

## AN INTERPRETATION OF STERILITY IN CERTAIN PLANTS.<sup>1</sup>

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(Read April 23, 1915.)

It is obvious that it is impossible to investigate the cause of sterility in hybrids by the pedigree culture method when such sterility is complete. Occasionally, however, one finds hybrids which are not wholly sterile. Such is the case in the historic cross, *Nicotiana rustica* L.  $\times$  *Nicotiana paniculata* L. This hybrid holds an enviable position in experimental botany, since it was the first artificial hybrid to be studied. It was made by Kölreuter in 1760 and was studied by him for several years by means of back crosses with each parent.

This cross I repeated in 1909, using as the *N. rustica* parent a small variety *N. rustica humilis* Comes obtained from Dr. Comes through the kindness of Dr. D. G. Fairchild. It has now been studied through five generations both in the field (general morphology) and in the laboratory (histology and cytology). The essential points noted, as I see them, are as follows:

Two species giving extremely uniform progeny when selfed have, when crossed, given an intermediate  $F_1$  population as uniform as themselves, and an inordinately variable  $F_2$  population.

The germination of  $F_2$  seeds varies in different samples from 20 to 60 per cent.

Practically no two  $F_2$  plants are alike, and the parental forms are recovered once in every 100 to 200  $F_2$  plants.

In  $F_1$ , from 1 to 6 per cent. of the ♀ gametes are functional. It is impossible to determine the percentage of viable ♂ gametes formed from the pollen mother cells, but from 2 to 6 per cent. of the

<sup>1</sup> It is impossible to reproduce the photographs shown by means of lantern slides, but an illustrated paper giving the details of the investigation is to be published shortly.

pollen found is morphologically perfect. The maturation difficulty in spermatogenesis is largely at the first spermatocyte division.

$F_1$  plants are as fertile *inter se* as in back crosses with either parent.

Segregation of determiners for fertility occurs in  $F_1$ , so that by recombination some perfectly fertile plants are obtained in  $F_2$ .

Nearly all fertile  $F_2$  plants selfed give only fertile progeny. Occasionally a fertile  $F_2$  plant selfed may give a slightly non-fertile daughter.

Numerous combinations that should be possible in  $F_2$  are omitted in the population obtained. Combinations approaching *N. rustica* seem to be more frequent than those approaching *N. paniculata*. Many more homozygous combinations occur in  $F_2$  than might be expected.

Perfectly fertile plants giving perfectly fertile progeny, heterozygous for many allelomorphs, do occur in  $F_2$ .

No more than a very general formal interpretation of these facts can be made at present, but assuming that the chromosomes carry the hereditary character determiners, and that these react with the cytoplasm under proper environmental conditions to build up the soma, attention is called to the following possibilities of satisfying the conditions imposed by the data.

1. There is selective elimination of  $F_2$  zygotes.
2. There is no evidence of selective fertilization. (I infer this from the fact that  $F_1$  plants are as fertile *inter se* as in backcrosses.)
3. The selective elimination of non-functional gametes that must occur in  $F_1$  and the recombinations of functional gametes that give different grades of fertility in  $F_2$  cannot be interpreted by a Mendelian factorial notation without subsidiary assumptions, but possibly may be the result of one of the two following hypotheses:

(A) Through multipolar spindles, mating of non-homologous chromosome pairs at synapsis, or other mitotic aberrations at the reduction division, the 24 chromosomes characterizing each of the two species may be irregularly distributed at gametogenesis. If some of these irregular gametes may function, the majority of the experimental data are satisfied, but there are reasons which there is not time to consider which make this scheme improbable.

(B) On the other hand the facts may be interpreted without assuming irregularities of chromosome distribution if (1) there is a group of chromosomes in each parent that cannot be replaced by chromosomes from the other parent; if (2) there is a group of chromosomes from each parent, a percentage of which may be replaced by chromosomes from the other parent, but where functional perfection of the gametes varies as their constitution approaches that of the parental forms; if (3) there are other chromosomes that have no effect on fertility and therefore can promote recombinations of characters in the progeny of fertile  $F_2$  plants; if (4) a naked male nucleus entering the normal cytoplasm of the egg in the immediate cross can cause changes in the cytoplasm that will affect future reduction divisions; if (5) this abnormally formed cytoplasm is not equitably distributed in the dichotomies of gametogenesis in the  $F_1$  generation; if (6) it follows from (4) and (5) that  $F_2$  zygotes may be formed which are less perfect in their gamete forming mechanism than those of the  $F_1$  generation; and if (7) the heterotypic division of gametogenesis does not necessarily form two cells alike in their viability.

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